## REMARKS

### Present Status of the Application

The Office Action rejected claims 1-20 under 35 U.S.C. 112, 1st paragraph, as containing subject matter which was not described in the specification in such as way as to enable one skilled in the art to which it pertains, connected, to make and/or to use the invention. Claims 1-3, 5 and 6 were rejected under 35 U.S.C. 102(e), as being anticipated by Walsh et al. (US Patent No. 6,228,741). Claims 1-3, 6-10, 13-16 and 19-20 were rejected under 35 U.S.C. 102(e), as being anticipated by Kuehne et al. (US Patent No. 6,146,975). Claims 4 and 7 were rejected under 35 U.S.C. 103(a) as being unpatentable over Walsh and in view of Breiten et al. (US Patent No. 4,836,885). Claims 4-5, 11-12 and 17-18 were rejected under 35 U.S.C. 103(a) as being unpatentable over Kuehne and in view of Breiten et al. (US Patent No. 4,836,885). Claims 8-13 were further rejected under 35 U.S.C. 103(a) as being unpatentable over Breiten et al. (US Patent No. 4,836,885) and in view of Kuehne.

Claims 1, 8, 14 and 20 have been amended, while the specification and drawings have been amended. This Amendment is promptly filed to place the above-captioned case in condition for allowance. No new matter has been added to the application by the amendments made to the claims, specification or otherwise in the application. After entering the amendments and considering the following remarks, a notice of allowance is respectfully solicited.

**Discussion of 112 rejections**

*Claims 1-20 were rejected under 35 U.S.C. 112, 1st paragraph, as containing subject matter which was not described in the specification in such as way as to enable one skilled in the art to which it pertains, connected, to make and/or to use the invention.*

Applicant has amended the drawings. Submitted for the Examiner's approval are the revised formal drawings and their marked copies with the changes indicated with red ink.

The claims have been amended to exclude the term "vertical", while the specification has been amended in comply with the claims.

Withdrawal of this rejection is respectfully requested.

**Discussion of 102 Rejections**

*Claims 1-3, 5 and 6 were rejected under 35 U.S.C. 102(e), as being anticipated by Walsh et al. (US Patent No. 6,228,741). Claims 1-3, 6-10, 13-16 and 19-20 were rejected under 35 U.S.C. 102(e), as being anticipated by Kuehne et al. (US Patent No. 6,146,975).*

Applicants respectfully traverse the rejections for at least the reasons set forth below.

The independent claims 1, 8 and 14 have been amended to more clearly define the method according to the present invention. No new matter has been added to the application by the amendments made to the claims.

From Fig. 1D, it clearly shows that the thin film 150 above the trenches are not removed because of the protection of the screen layer 160b above the trenches, while the thin film 150 on the insulation layer 140 above the active areas is removed along with the screen layer 160a.

As amended, claims 1, 8 and 14 respectively recite:

1. (Once Amended) A method for forming a shallow trench isolation structure, comprising the steps of:

providing a substrate comprising at least a trench and an active region covered by a mask layer and isolated by the trench;

forming an insulation layer to fill the trenches and to cover the mask layer by high density plasma chemical vapor deposition, wherein a surface of the insulation layer is higher than a surface of the substrate and lower than a surface of the mask layer;

forming a thin film on the insulation layer;

forming a screen layer on the thin film by a fluid precursor;

***removing the screen layer and the thin film over the active region, while the screen layer and the thin film above the trenches are not removed;***

***removing the insulation layer above the active areas to expose the mask layer, while the screen layer and the thin film above the trench protect the insulation layer in the trench***;

removing the screen layer to expose the thin film in the trench;

removing the thin film in the trench to expose the insulation layer; and

removing the mask layer above the active region.

8. (Once Amended) A method for forming a shallow trench isolation structure, comprising:

providing a substrate comprising a plurality of trenches and a plurality of active areas, wherein the active areas are covered by a pad oxide layer and a mask layer;

forming an insulation layer in the trenches and on the mask layer, wherein the insulation layer in the trenches has a surface higher than a surface of the substrate and lower than a surface of the mask layer, and wherein the insulation layer on the mask layer has sidewalls;

***forming a thin film on the insulation layer above the active areas and the trenches, wherein the thin film formed on the sidewalls of the insulation layer is thinner than the thin film formed on other positions of the insulation layer;***

***forming a screen layer on the thin film by a fluid precursor, wherein a thickness of the screen layer formed above the active areas is thinner than a thickness of the screen layer formed above the trenches;***

***removing the screen layer and the thin film above the active areas, while the screen layer and the thin film above the trenches are not removed;***

***removing the insulation layer above the active areas, while the screen layer and the thin film above the trenches protect the insulation layer in the trench;***

removing the screen layer above the trenches;

removing the thin film above the trenches; and

removing the mask layer above the active areas.

14. (Once Amended) A method for forming a shallow trench isolation structure, applicable to a substrate having at least an active area on the substrate, at least a trench surrounding the active area, and a pad oxide layer and a mask layer formed sequentially on the substrate in the active area, the method comprising:

forming an insulation layer in the trenches and on the mask layer, wherein the insulation layer in the trench has a thickness ranged between a sum of a depth of the trench and a thickness of the pad oxide and a sum of the depth of the trench plus a thickness of both the mask layer and the pad oxide layer;

forming a thin layer on the insulation layer;

forming a screen layer on the thin layer above the trench;

***removing the screen layer and the thin layer above the mask layer and above the active area, while the screen layer and the thin layer above the trench are not removed;***

***removing the insulation layer above the mask layer and above the active area, while the screen layer and the thin film above the trench protect the insulation layer in the trench;***

removing the screen layer above the trench;

removing the thin layer above the trench; and

removing the mask layer above the active area.

***(Emphasis added)***

Applicant respectfully asserts that the method claimed in the present invention patentably distinguishes over Walsh's or Kuehne's method, because the references at least lack these features emphasized above (in bold).

Walsh discloses depositing HDP oxide 40 to fill the trench 25 and on the nitride 30 and followed by in-situ sputtering etch (Step 150) to make sure the edges of the nitride 30 being exposed. Next, a conformal nitride cap layer 50 is formed along the profile of the HDP oxide 40. A patterned photoresist 60 is formed above the trench as a mask for patterning and etching the conformal nitride cap layer 50, and the photoresist 60 is then removed, as shown in Fig. 7. The HDP oxide 40 is removed with the patterned cap nitride layer 50 as a mask.

Even considering the nitride cap layer 50 and photoresist 60 comparable as the thin film and the screen layer, as stated by the Office Action, Walsh fails to teach or suggest removing the screen layer and the thin film over the active region, while the screen layer and the thin film above the trenches are not removed. Moreover, Walsh does not disclose removing the insulation layer above the active areas to expose the mask layer, while the screen layer and the thin film above the trench protect the insulation layer in the trench. Therefore, Walsh did not anticipate

the present invention as suggested by the Office Action, to arrive at the present invention as recited in independent claim 1.

Kuehne discloses filling the trenches by blanket depositing oxide layer 27, preferably by HDP, and then forming a nitride stop layer 31. After patterning the nitride stop layer 31 by using the photoresist 33 as a mask, photoresist 33 is stripped to leave the patterned nitride stop layer 31 above the trench, as shown in Fig. 8. CMP is then performed to planarize the oxide layer 27. In fact, Kuehne discloses a CMP process for STI technology involving dual polishing stop layers.

Even considering the nitride stop layer 31 and photoresist 33 comparable as the thin film and the screen layer, as stated by the Office Action, Kuehne fails to teach or suggest removing the screen layer and the thin film over the active region, while the screen layer and the thin film above the trenches are not removed. Moreover, Kuehne does not disclose removing the insulation layer above the active areas to expose the mask layer, while the screen layer and the thin film above the trench protect the insulation layer in the trench. Therefore, Kuehne did not anticipate the present invention as suggested by the Office Action, to arrive at the present invention as recited in independent claims 1, 8 and 14.

For at least the foregoing reasons, all pending claims patently define over the cited references and should be allowed. As a result, withdrawal of these rejections is respectfully requested.

Discussion of 103 Rejections

*Claims 4 and 7 were rejected under 35 U.S.C. 103(a) as being unpatentable over Walsh and in view of Breiten et al. (US Patent No. 4,836,885). Claims 4-5, 11-12 and 17-18 were rejected under 35 U.S.C. 103(a) as being unpatentable over Kuehne and in view of Breiten et al. (US Patent No. 4,836,885). Claims 8-13 were further rejected under 35 U.S.C. 103(a) as being unpatentable over Breiten et al. (US Patent No. 4,836,885) and in view of Kuehne.*

Applicant respectfully transverse these rejections for at least the following reasons.

As discussed above, both Walsh and Kuehne lack these features emphasized above. Moreover, Kuehne teaches away by disclosing the CMP process for STI.

As noted in the Office Action, Breiten fails to teach or suggest "a surface of the insulating layer in trenches is higher than a surface of the substrate and lower than a surface of the mask layer" and "removing the mask layer above the active regions". In fact, Breiten teaches removing the resist layer 27 and the nitride layer 25 both above the trench 19 and the active areas, excepting above the wider trench 17. Accordingly, Breiten fails to teach or suggest these features emphasized above and does not remedy deficiencies of Walsh or Keuhne.

In contrary, in the present invention, the thin film and screen layer have uneven thickness above the trenches or the active areas. In the present invention, the screen layer above the active areas is removed without completely removing the screen layer above the trenches, because the screen layer formed above the active areas is thinner. After removing the screen layer above the active areas, the thin film above the active areas is removed. The remaining screen layer above the trenches protects the underlying thin film. **Therefore, the screen layer and the thin film**

**above the active areas are removed, while the screen layer and the thin film above the trenches still remain to protect the underlying insulation layer in the trenches.**

As mentioned above, Kuehne fails to remedy Breiten's deficiencies. Moreover, it is unlikely for one skilled in the art to combine Breiten with Kuehne, because Kuehne adopts the CMP process, which is impractical to be applied in Breiten's process. On the contrary, in the present invention, **no CMP is required** to form shallow trench isolations, thus preventing scratches or defects formed on the surface of the active areas and the STI.

Thus, even if combined, the combination of the cited references does not render the claims 1, 8 and 14 of the present invention obvious. For at least the same reasons, dependent claims are submitted to patently define over the cited references. Reconsideration and withdrawal of the rejection are respectfully requested.

## CONCLUSION

For at least the foregoing reasons, it is believed that all pending claims are in proper condition for allowance. If the Examiner believes that a telephone conference would expedite the examination of the above-identified patent application, the Examiner is invited to call the undersigned.

Respectfully submitted,
J.C. PATENTS

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## VERSION WITH MARKINGS TO SHOW CHANGES MADE

### In The Specification:

Paragraph beginning at line 22 of page 2 has been amended as follows:

The formation method of the insulating layer mentioned above is, for example, high density plasma chemical vapor deposition (HDPCVD). The high density plasma of HDPCVD has a bombarding effect; therefore the insulating layer has substantially vertical side[ ]walls above the edge of the active areas. The screen layer is formed by, for example, floatable precursors. The floatable precursor fills up the low-lying place, i.e., above the trenches, to protect the thin layer above trenches. Hence, when the thin layer and the insulating layer above the active areas are removed, the insulating layer above the trenches is not hurt.

Paragraph beginning at line 22 of page 4 has been amended as follows:

The material of the insulating layer 140 includes, for example, silicon oxide, and the formation method of the insulating layer 140 includes, for example, HDPCVD. Since the high density plasma of HDPCVD has an etching effect simultaneously during deposition, the deposition rate to the etching rate ratio can thus be controlled to result in obtaining substantially vertical sidewalls 145 of the insulating layer 140 over the active regions 105 above the substrate 100. For example, by tuning process conditions, including D/S ratio about 4.0, bias (RF power) about 3000kW, temperature about 300-380°C and pressure about 5 mT, a substantially vertical sidewall can be formed. Preferably, the process parameters can be further fine-tuned to obtain substantially vertical sidewalls, as the following exemplary conditions: RF power (top): 1200-1450W; RF power (side): 2900-3380W; RF bias power match box (off); Ar gas flow rate: 80-135 sccm; Ar gas (top) flow rate: 10-20 sccm; $O_2$ gas flow rate: 188-245 sccm; $O_2$ gas (top) flow rate: 22-40 sccm; $SiH_4$ gas flow rate: 100-128 sccm; $SiH_4$ gas (top) flow rate: 12-22 sccm; and pressure control: T.V. setting 700-880 steps. However, the present invention is not limited by the aforementioned parameters, since these parameters are only exemplary.

Paragraph beginning at line 13 of page 5 has been amended as follows:

A thin film 150 is formed on the insulting layer 140. The material of the thin film 150 is preferably selected from a material with good removal selectivity over the insulating layer 140. For example, when the insulating layer 140 is made of silicon oxide, the thin film 150 material can be made of silicon nitride or polysilicon. The thickness of the thin film 150 is preferably about 100 to about 500 Å, for example, about 200Å, which is about the thickness of the pad oxide 110. The formation method of the thin film 150 is, for example, chemical vapor deposition. Due to the substantially vertical geometry of the sidewalls 145, the thin film 150 deposited on the sidewalls 145 is thinner than that on other positions. As shown in Fig. 1B, while a sputtering step is applied instead of chemical vapor deposition, almost no thin film 150 can be formed on the sidewalls 145.

**In The Claim:**

Claims 1, 8, 14 and 20 have been amended as follows:

1. (Once Amended) A method for forming a shallow trench isolation structure, comprising the steps of:

providing a substrate comprising at least a trench and an active region covered by a mask layer and isolated by the trench;

forming an insulation layer to fill the trenches and to cover the mask layer by high density plasma chemical vapor deposition, wherein a surface of the insulation layer is higher than a surface of the substrate and lower than a surface of the mask layer;

forming a thin film on the insulation layer;

forming a screen layer on the thin film by a fluid precursor;

removing the screen layer and the thin film over the active region, while the screen layer and the thin film above the trenches are not removed;

removing the [insulating]insulation layer above the active areas to expose the mask layer, while the screen layer and the thin film above the trench protect the insulation layer in the trench;

removing the screen layer to expose the thin film in the trench;

removing the thin film [above]in the trench to expose the insulation layer; and

removing the mask layer above the active region.

8. (Once Amended) A method for forming a shallow trench isolation structure, comprising:

providing a substrate comprising a plurality of trenches and a plurality of active areas, wherein the active areas are covered by a pad oxide layer and a mask layer;

forming an insulation layer in the trenches and on the mask layer, wherein the insulation layer in the trenches has a surface higher than a surface of the substrate and lower than a surface of the mask layer, and wherein the insulation layer on the mask layer has [vertical ]sidewalls;

forming a thin film on the insulation layer above the active areas and the trenches, wherein the thin film formed on the [vertical ]sidewalls of the insulation layer is thinner than the thin film formed on other positions of the insulation layer;

forming a screen layer on the thin film by a fluid precursor, wherein a thickness of the screen layer formed above the active areas is thinner than a thickness of the screen layer formed above the trenches;

removing the screen layer and the thin film above the active areas, while the screen layer and the thin film above the trenches are not removed;

removing the [insulating]insulation layer above the active areas, while the screen layer and the thin film above the trenches protect the insulation layer in the trench;

removing the screen layer above the trenches;

removing the thin film above the trenches; and

removing the mask layer above the active areas.

14. (Once Amended) A method for forming a shallow trench isolation structure, applicable to a substrate having at least an active area on the substrate, at least a trench[es]

surrounding the active area, and a pad oxide layer and a mask layer formed sequentially on the substrate in the active area, the method comprising:

forming an insulation layer in the trenches and on the mask layer, wherein the insulation layer in the trench has a thickness ranged between a sum of a depth of the trench and a thickness of the pad oxide and a sum of the depth of the trench plus a thickness of both the mask layer and the pad oxide layer;

forming a thin layer on the insulation layer;

forming a screen layer on the thin layer above the trench[es];

removing the screen layer and the thin layer above the mask layer and above the active area, while the screen layer and the thin layer above the trench[es] are not removed;

removing the [insulating]insulation layer above the mask layer and above the active area, while the screen layer and the thin film above the trench protect the insulation layer in the trench;

removing the screen layer above the trench[es];

removing the thin layer above the trench[es]; and

removing the mask layer above the active area[s].

20. (Once Amended) The method of claim 14, wherein the insulation layer is formed with a [vertical ]sidewall by controlling an etching/deposition ratio of a high density plasma chemical vapor deposition step.

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